

## New subspecies for the south-western Australian species *Boronia clavata* and *B. denticulata* (Rutaceae)

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### Abstract

The south-western Australian species *Boronia clavata* Paul G. Wilson and *B. denticulata* Sm. (Rutaceae) are revised and *B. clavata* subsp. *grandis* Duretto from Cape Arid National Park and *B. denticulata* subsp. *whoogarupensis* Duretto from in and near western Fitzgerald River National Park are newly described.

### Introduction

*Boronia* sections *Boronia* and *Pedunculatae* (Rutaceae) have recently been revised for Western Australia (Wilson 1971, 1998; see also Duretto *et al.* 2013). New collections of *B. clavata* Paul G. Wilson (section *Boronia*) from Cape Arid National Park, and *B. denticulata* Sm. (section *Pedunculatae*) from the Whoogarup Range in Fitzgerald River National Park, have precipitated revision of both species. In both species there are geographically isolated populations that have minor morphological differences, e.g. flower size and sepal shape, and these taxa are formally recognised below as subspecies. Results of these revisions are discussed under each species below.

### Material and methods

Herbarium specimens from PERTH and NSW were studied. Type specimens were viewed online at JSTOR Global Plants (<https://plants.jstor.org>).

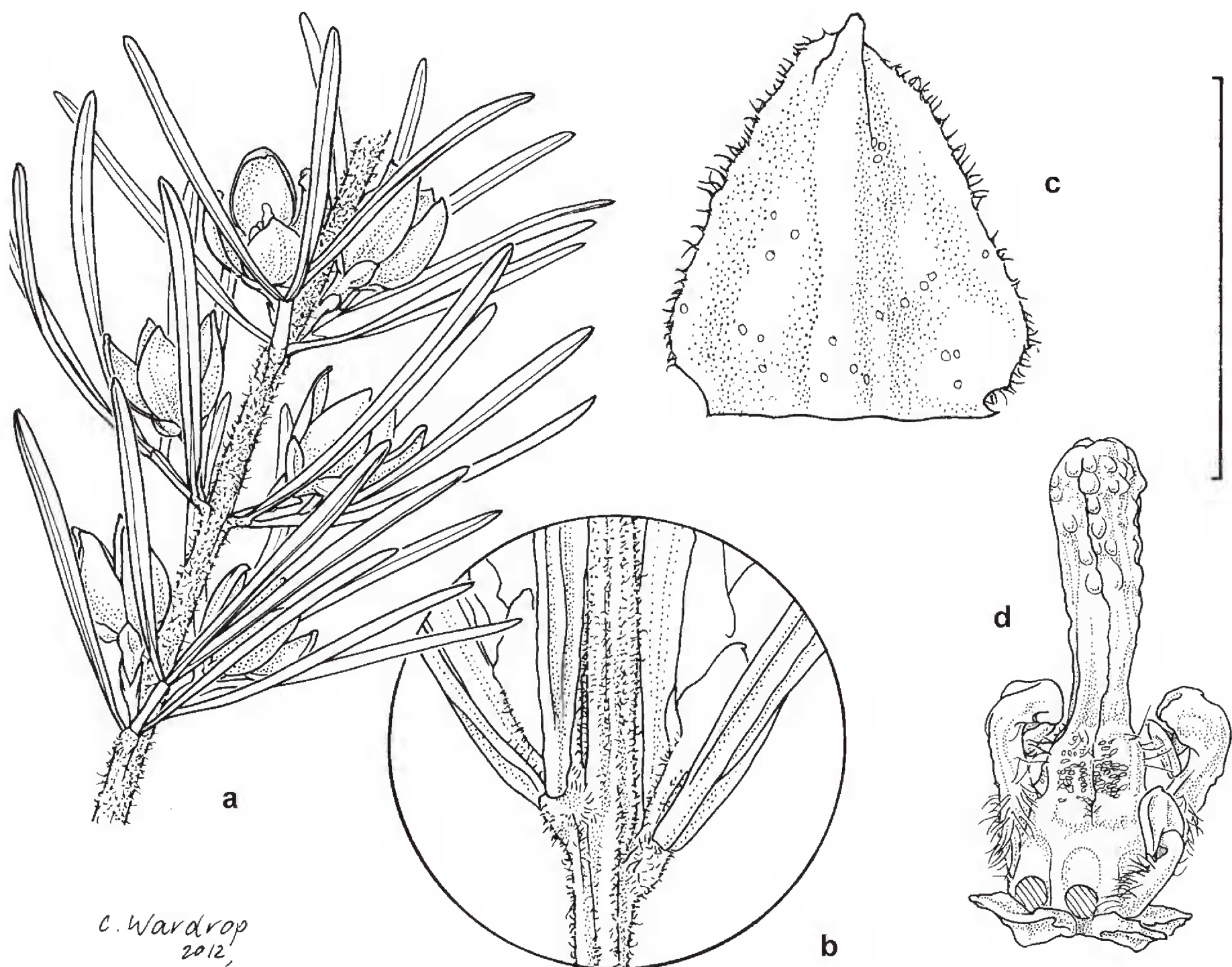
### Taxonomy

*Boronia clavata* Paul G. Wilson, *Nuytsia* 1(2): 199 (1971)

Type citation: *K. Newbey* 2876, Bremer River ca. 10 mi from mouth, 15 ix 1969 (holo: PERTH; iso: K, MEL)

Type: WESTERN AUSTRALIA: Bremer River, c. 16 km from mouth, 15 Sep 1969, *K. Newbey* 2876 (holotype: PERTH 1149954; isotypes: K 717250, MEL 704714, NSW 776511, PERTH 1149962; types viewed at Global Plants, <https://plants.jstor.org>).

Erect shrub to 5 m tall; branchlets puberulous or puberulous with scattered longer hairs to 0.5 mm long, with faint decurrent leaf bases. Leaves opposite-decussate, subsessile or with petiole to 1 mm long, 3–5(–7)-foliolate, mostly glabrous with few scattered hairs or sparsely to densely puberulous, sometimes with scattered longer hairs; rachis segments 3.5–4 mm long; leaflets linear to linear-cuneate, 10–35 mm long, 0.9–2.0 mm wide, margins flat, tip obtuse to acute. Flowers axillary, solitary, erect, 4-merous. Peduncle absent or to 2 mm long, puberulous; bracteoles 1–2.5 mm long; pedicels narrowly turbinate, puberulous, 2–3 mm long. Sepals deltate to narrowly deltate, 1–3 mm long, 1–1.75 mm wide, with subapical apiculum abaxially, glabrous with a few hairs near tip or ciliate or sparsely puberulous or densely puberulous. Petals pale yellow–green, broadly elliptic, 4.5–9 mm long, with subapical apiculum abaxially, abaxial and adaxial surfaces puberulous near margins, deciduous with fruit. Stamens 8; antisepalous stamens c. 3 mm long, filaments pilose near base, swollen near apex and appearing arched, anthers 0.75–1 mm long; antipetalous stamens c. 1 mm long, filaments pilose near base, slightly swollen near apex, anthers c. 1 mm long. Disc shortly columnar. Ovary sparsely hirsute; style and stigma together 3–4.5 mm long, massive, clavate and lobed. Cocci (see subsp. *clavata*). **Figs. 1 & 2.**



**Fig. 1.** *Boronia clavata* subsp. *clavata*. a – flowering stem; b – stem detail; c – sepal, abaxial view; d – gynoecium, 3 stamens removed. a-d – Newbey 2876 (NSW 776511, isotype). Scale bar = 20 mm for a, 2 mm for b, 5 mm for c & d. Reproduced with permission from the Australian Biological Resources Study and Catherine Wardrop (originally published in Duretto [2013], Fig. 25K-N).

**Notes:** *Boronia clavata* was described by Wilson (1971) and was until recently considered to be a localised endemic of the Bremer River and Gairdner River areas, west of Fitzgerald River National Park in Western Australia. Between 2011 and 2017, plants were collected from Cape Arid National Park and were identified as being close to *B. clavata* and possibly an undescribed species. These plants were notable because of their large size (to 5 m tall) and that some plants had hairy leaves (the typical form of *B. clavata* is up to 2 m tall and has glabrous leaves). Collections from this area indicated that there were plants with almost glabrous leaves (e.g., *Young DAY\_WA17\_20*) and plants with hirsute leaves (e.g., *Young DAY\_WA17\_21*) growing in close proximity



that were otherwise very similar in both flower and leaf morphology. Plants from Cape Arid differ from the typical form in having longer sepals and mostly longer petals and puberulous branches with scattered longer hairs to 0.5 mm (versus just puberulous, with all hairs to c. 0.1 mm long). They are also taller and wider than the typical form but this may reflect an increase in individual stature facilitated by a longer period of time since the last fire. The differences between the two populations warrants taxonomic recognition and plants from Cape Arid National Park are described below as *B. clavata* subsp. *grandis* Duretto.

**Conservation status:** The species is listed as Endangered under both Western Australian and Commonwealth legislation though these listings are probably based on information of the typical subspecies only. Population size is rarely documented on herbarium sheets and then the species is usually reported as being rare or occasional where found.

### Key to the subspecies of *Boronia clavata*

1. Sepals deltate to narrowly deltate, 1–2 mm long; petals 4.5–7 mm long; branchlets puberulous (a dense covering of short hairs to 0.1 mm long) ..... *B. clavata* subsp. *clavata*
1. Sepals narrowly deltate, 2.5–3 mm long; petals 8–9 mm long; branchlets puberulous with scattered longer hairs (to 0.5 mm long) ..... *B. clavata* subsp. *grandis*

#### *Boronia clavata* Paul G. Wilson subsp. *clavata*

Erect shrub to 2.1 m tall; branchlets puberulous. Leaves subsessile with petiole to 0.5 mm long, mostly glabrous with few scattered hairs or scarcely puberulous. Peduncle absent or minute; bracteoles c. 1 mm long. Sepals deltate to narrowly deltate, 1–2 mm long, 1–1.5 mm wide, glabrous with a few hairs near tip or ciliate or sparsely puberulous. Petals 4.5–7 mm long. Cocci glabrous, 4–5 mm long, 2–2.5 mm wide. **Fig. 1.**

**Distribution:** Confined to the Bremer River and Gairdner River areas in south-western Australia.

**Habitat:** Alluvial flats of sandy loam over spongelite with heath or low woodland.

**Flowering and fruiting:** Flowering material has been collected from September to November and in February; fruiting material in November.

**Conservation status:** The subspecies is known from a restricted area and the known population appears to be small. There have not been recent collections from the Gairdner River area and the taxon maybe extinct there.

**Representative specimens examined:** (12 specimens seen; collections details obfuscated for conservation reasons) WESTERN AUSTRALIA: SW Bay River (Bremer R.), Garden Inlet Road, 6 Sep 1993, *C.J. Robinson 1151* (PERTH); Devil Bank, 34°18'S 119°13'E, 17 Nov 1999, *S. Barrett 811* (PERTH); Northern bank of Lizzie Creek, near junction with Bremer River, 34°22'S 119°21'E, 26 Feb 2000, *S. Barrett 830* (PERTH); Gairdner River, 20 Sep 1969, *K. Newbey 2883* (PERTH); Devil Creek, 34°17'S 119°13'E, 17 Nov 1999, *S. Barrett 812* (PERTH).

#### *Boronia clavata* subsp. *grandis* Duretto, *subsp. nov.*

Type: WESTERN AUSTRALIA: Just W of Thomas Fisheries, Cape Arid National Park, 33°59'S 123°13'E, 18 Sep 2017, *D.A. Young DAY\_WA17\_21* (holotype: PERTH 8981884).

**Etymology:** The subspecific epithet is derived from the Latin *grandis* (large) and refers to plants being larger and having larger flowers than those of the typical subspecies.

Erect shrub to 3(–5) m tall; branchlets puberulous with scattered longer hairs to 0.5 mm long. Leaves subsessile or with petiole to 1 mm long, mostly glabrous with few scattered hairs or densely puberulous with scattered longer hairs. Peduncle absent or to 2 mm long; bracteoles 2–2.5 mm long. Sepals narrowly deltate, 2.5–3 mm long, 1.5–1.75 mm wide, ciliate or densely puberulous. Petals (6–)8–9 mm long. Cocci not seen. **Fig. 2.**

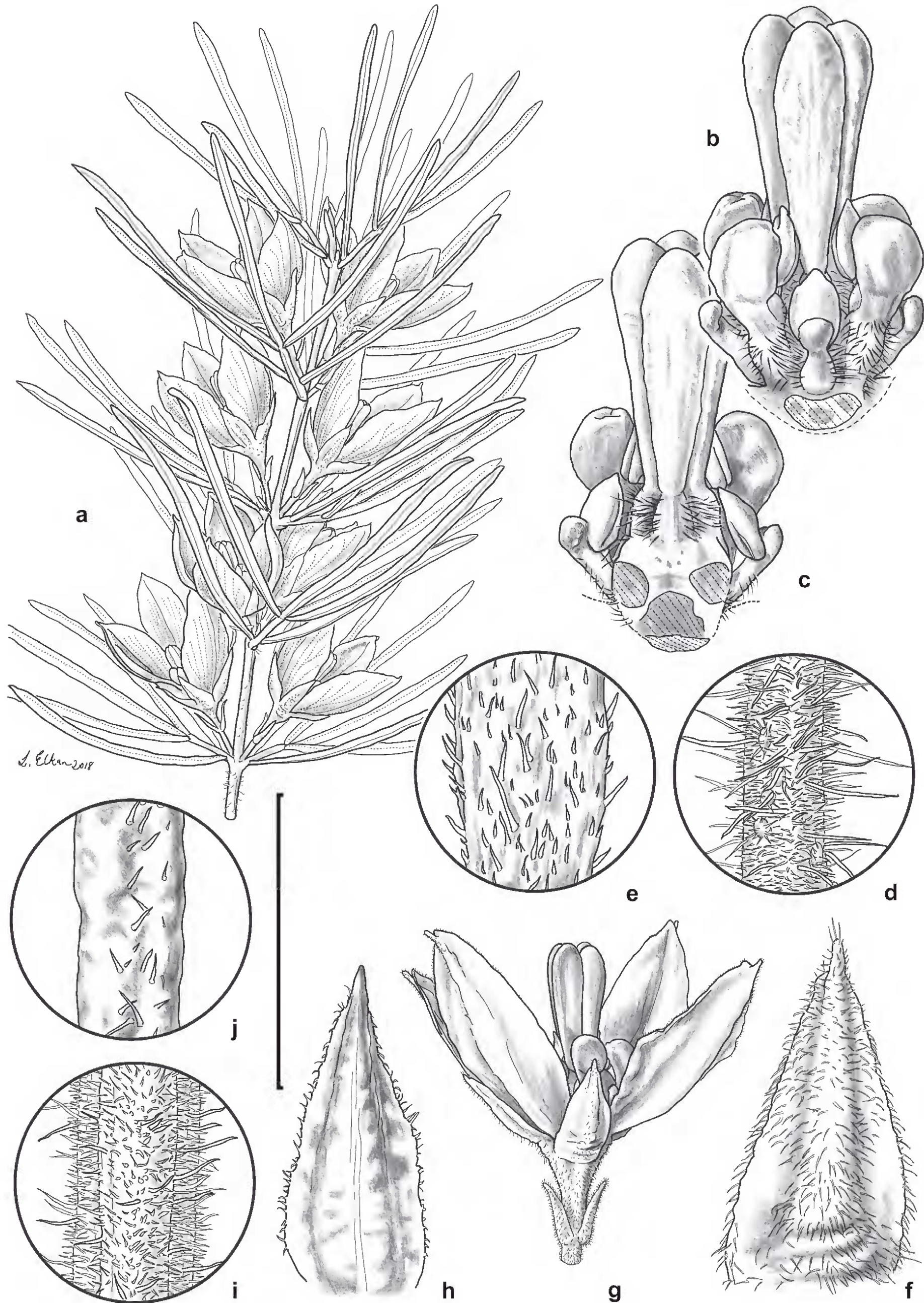
**Distribution:** Apparently confined to a limited area near Thomas Fishery in Cape Arid National Park, south-western Australia.

**Habitat:** Found in drainage lines associated with a massive granite outcrop in closed thick scrubland.

**Flowering:** Flowering material has been collected in October and November.

**Conservation status:** The subspecies appears to be very restricted in distribution and detailed surveys are required to ascertain population size and conservation status. It is found in Cape Arid National Park.





**Fig. 2.** *Boronia clavata* subsp. *grandis*. a – flowering stem; b – gynoecium & stamen detail; c – gynoecium & stamen detail with 1 antisepalous & 2 antipetalous stamens removed; d & i – stem detail showing two types of hair; e – leaf adaxial view; f & h – sepal abaxial view; g – flower; j – leaf adaxial view. a–g – DAY\_WA17\_21 (PERTH 08981884); h–j – Young DAY\_WA17\_20 (PERTH 08981876). Scale bar = 20 mm for a, 5 mm for b & c, 2 mm for d, e, i & j, and 10 mm for g.



**Specimens examined:** (collections details obfuscated for conservation reasons) Western Australia: Cape Arid National Park, 19 Oct 2011, *G. Wardell-Johnson & K. Gunnae* AR 314 (PERTH); *ibid*, 8 Oct. 2013, *W. Gill 1/1013* (PERTH, NSW); *ibid*, 11 Nov 2014, *E. Massenbauer 704-710* (704–705 – PERTH, NSW; 706–710 – PERTH); *ibid*, 18 Sep 2017, *D.A. Young DAY\_WA17\_20* (PERTH).

*Boronia denticulata* Sm., *Trans. Linn. Soc. London* 8: 284 (1807)

Type citation: Gathered at King George's Sound, by Mr. Menzies.

Type: WESTERN AUSTRALIA: King George Sound, west coast of New Holland, lat. 35, 1803, *A. Menzies* (holotype: LINN HS684.7; viewed at Global Plants, <https://plants.jstor.org>).

Slender shrub 1–3 m tall, glabrous apart from stamens; branches smooth. Leaves opposite-decussate, sessile, simple, linear-elliptic to narrow-elliptic to narrow-lanceolate to narrow-oblongate, 11–50 mm long, 1–15 mm wide; margins entire, almost entire with only very slightly raised glands, or slightly to distinctly glandular-dentate. Inflorescence an open cyme, mostly terminal, sometimes also in upper leaf axils; peduncle and secondary inflorescence branches 2–23 mm long; pedicels 5–20 mm long, 0.5–1.5 mm wide. Flowers 4-merous. Sepals deltate or narrowly deltate, 1.0–3.1 mm long, 0.7–2.1 mm wide, caducous. Petals light to dark pink, 4–9 mm long, 3–6 mm wide, caducous. Stamens 8; filaments 1.5–3 mm long, slightly glandular at tip or sometimes also with scattered glands along upper half, sparsely pilose, sometimes with only a few hairs near base; anthers non-apiculate. Disc cushion-like. Ovary glabrous; style glabrous; stigma minute. Cocci 3–3.5 mm long, 1.7–2.5 mm wide, truncate, glabrous. Seed 1.5–2.5 mm long, 0.75–1.5 mm wide. **Figs. 3 & 4.**

**Notes:** *Boronia denticulata* is found in south west Australia from Denmark to Cape Arid National Park and is strikingly variable in leaf morphology (Fig. 3). Material closely matching the type has narrowly elliptic leaves with distinctly denticulate margins and has been collected mainly from Denmark to Albany, rarely further east to the Fitzgerald River, Fitzgerald River National Park, as far inland as Stirling Range National Park, and then, further east, at Cape Le Grand and Cape Arid National Parks. Most plants from between Albany and Hopetoun have leaves that are almost entire with only very subtle denticulations; a few collections of this form have also been made between Albany and Denmark as well as at Cape Arid. The entire-leaved form matches the type of *B. chironiifolia* Bartl. Another form from the King George Sound (Albany) and Denmark areas has larger obovate denticulate leaves, thicker and slightly glaucous inflorescence parts than other plants. This form has only rarely been collected and it has been suggested it may be an intergradation between *B. denticulata* and *B. fastigiata* Bartl. (Duretto et al. 2013). Some plants from Cape Le Grand National Park also display these features, though to a lesser degree.

In 2011, material from a large plant of *B. denticulata* was collected from the Whoogarup Range in eastern Fitzgerald River National Park (*Rathbone DAR 620*). The specimen was striking in that it had linear to narrowly elliptic leaves with more or less entire margins, a very open and large inflorescence with very narrow pedicels, and large flowers with narrowly deltate sepals (verses deltate sepals as seen usually in *B. denticulata*). On initial examination the specimens looked like an undescribed species. Detailed examination of herbarium specimens held at PERTH and NSW indicated that the situation was not so straightforward. Specimens from the Whoogarup Range had been collected before (*George 1902*, *George 7192*) and these do not have the significantly larger inflorescence parts and petals of the *Rathbone DAR 620* collection, though they were at the upper end of the range seen elsewhere in *B. denticulata*. In addition, there were herbarium specimens collected in eastern Fitzgerald River National Park and west of the Whoogarup Range, at Thumb Peak (*Newbey 2723*), Middle Mount Barren (*Gardener 9162*) and Phillips River (*Wittwer 393*), that also had the narrowly deltate sepals and large inflorescences and petals, though not as large as seen in the Whoogarup Range. The linear leaves are also seen elsewhere in *B. denticulata* (see Fig. 3e, f). All specimens east of the Fitzgerald River, mostly in the eastern portion of Fitzgerald National Park, have the distinctive narrowly deltate sepals. They are also found in a different habitat than other collections of the species: creek gullies as opposed to swamps. When occurring in swamps plants are often in standing water. The form found east of the Fitzgerald River, mainly in eastern Fitzgerald River National Park, is described below as *B. denticulata* subsp. *whoogarupensis* Duretto.

*Boronia denticulata* is a species that expresses a remarkable diversity of leaf form. This level of variation is also seen in the closely related *B. spathulata* Lindl. The variation may be representative of genetic differences or a response to the environment and/or the age of the plant. Striking differences in leaf morphology as a function of plant age and ecology are seen in other species of *Boronia*, for example in *B. ledifolia* Vent. of south-eastern Australia (Duretto 1999) and both *B. lanuginosa* Endl. and *B. lanceolata* F.Muell. of north-western Australia (Duretto 1997). Detailed population, morphological and molecular studies on *B. denticulata* and related species are warranted to ascertain whether the morphological variation seen is a function of ontology and age of the plants and/or the environment or represents actual taxonomic groups.





**Fig. 3.** *Boronia denticulata* subsp. *denticulata*: leaf and inflorescence variation. a, e, i & m – flowering branch; b, f, j & n – leaf shape; c, g, k & o – leaf margin detail; d, h, l & p – sepal abaxial view. a-d – O’Shea *s.n.* (PERTH 04370430); e-h – Cuneo 192 (NSW 391270); k-l – Sheath *s.n.* (NSW 393105); m-p – Goadby *s.n.* (NSW 393081). Scale bar = 30 mm for a, e, i & m, 15 mm for b, f, j & n; 7.5 mm for c, g, k & o, and 5 mm for d, h, l & p.



**Conservation status:** The species is widespread, found in several conservation reserves including Fitzgerald River, Cape Le Grand and Cape Arid National Parks, and appears secure. It is not listed as threatened under Western Australian or Commonwealth legislation.

### Key to the subspecies of *Boronia denticulata*

1. Sepals deltate, 1–2.1 mm long and wide ..... *B. denticulata* subsp. *denticulata*
1. Sepals narrowly deltate, 2.5–3 mm long, 0.75–1.1 wide ..... *B. denticulata* subsp. *whoogarupensis*

#### *Boronia denticulata* Sm. subsp. *denticulata*

*Boronia chironiifolia* Bartl. in J.G.C. Lehmann, *Pl. Preiss.* 1(2): 167 (1845).

Type: WESTERN AUSTRALIA: 17 miles [27 km] from Albany, 9 Nov. 1840, *L. Preiss 2027* (lectotype: LD 1002914, *fide* Wilson (1998, p. 134); isoelectotypes: MEL 1058492, MEL 1058493; GOET; types viewed at Global Plants, <https://plants.jstor.org>).

Leaves linear-elliptic to narrow-elliptic to narrow-lanceolate to narrow-oblongate, 11–50 mm long, 1–15 mm wide; margins distinctly glandular-dentate to almost entire with only very slightly raised glands or entire. Inflorescence: peduncle and secondary branches 2–15 mm long; pedicels 5–12(–20) mm long, 0.5–1.5 mm wide. Sepals deltate, 1.0–2.1 mm long and wide. Petals 4–7 mm long, 3–5 mm wide. **Fig. 3.**

**Distribution:** Found from Denmark to the Fitzgerald River, western portion Fitzgerald River National Park, inland to the Stirling Range, and then east of Esperance at Cape Le Grand and Cape Arid National Parks.

**Habitat:** Found in seasonally inundated wetlands and swamps, as well as *Melaleuca* open woodland, usually on sandy soils. Often collected in standing water.

**Flowering and fruiting:** Flowering material has been collected from April to January, and fruiting material from November to January

**Conservation status:** The subspecies is widespread, often locally abundant and found in numerous conservation reserves and does not appear to be threatened.

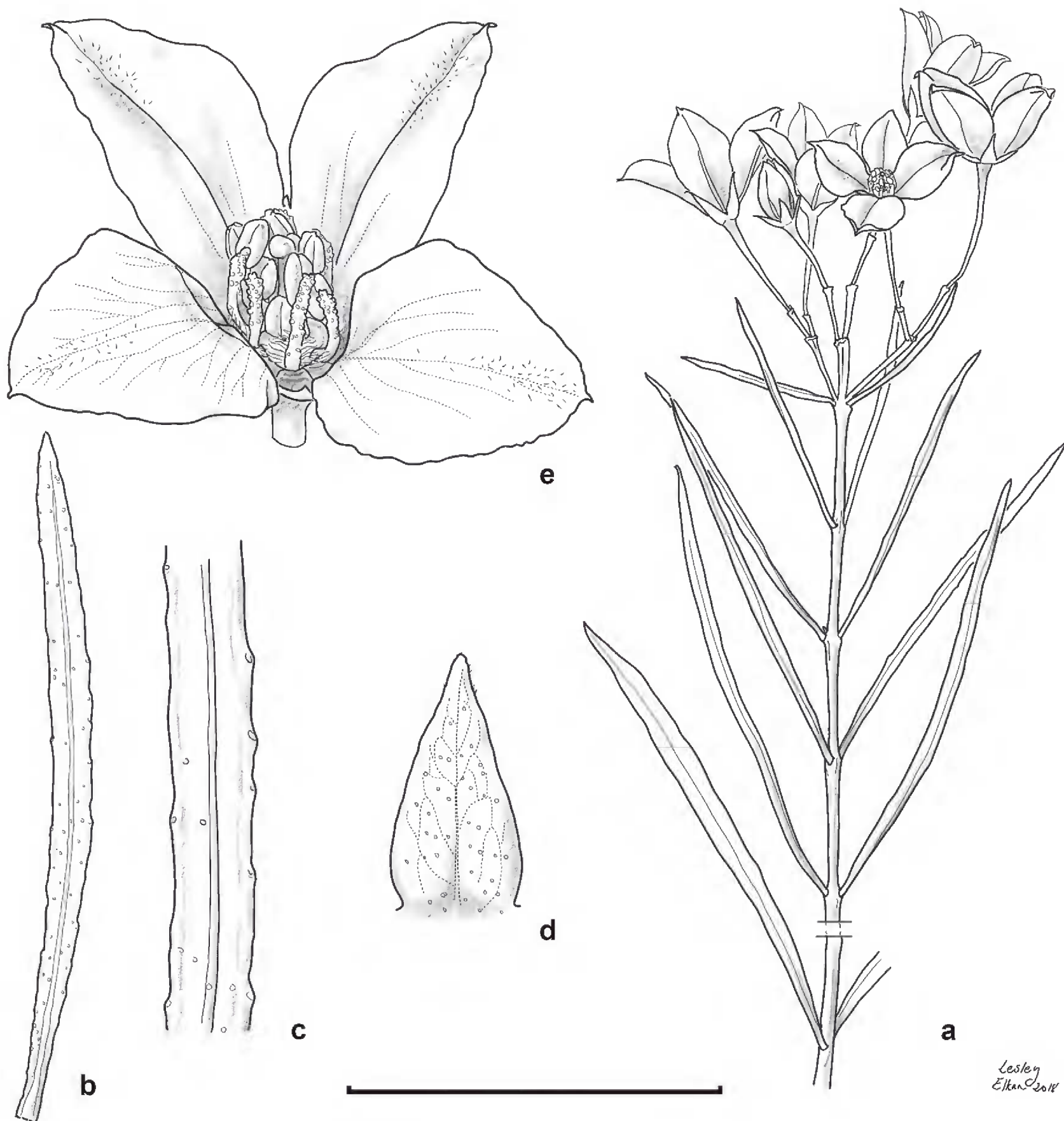
**Selected specimens (c. 90 seen):** WESTERN AUSTRALIA: Denmark River, Denmark, Aug 1936, *C.E. Gardner s.n.* (PERTH 935840); Nullaki Point, Wilsons Inlet, Denmark, 26 Jul 1987, *D. Tysoe 5429* (PERTH); Grasmere, 35°0'41"S 117°45'23"E, Oct 1991, *P. O'Shea s.n.* (PERTH 04370430); Norman's Inlet, Mt Manypeaks, c. 35 km E of Albany, 7 Aug 1986, *G.J. Keighery 8224* (PERTH); Albany, 1904, *H.E. Sheath s.n.* (NSW 393122); King George Sound, *Col. Goadby s.n.* (PERTH 934364); King George's Sound, 35°03'S 117°58'E, *B.T. Goadby s.n.* (NSW 393081); Kalgan River, Kamballup, 34°35'S 117°59'E, 10 Oct 1996, *R. Garstone s.n.* (PERTH 5640423); Kalgan River, below Old Kalgan Bridge, near Albany, 34°53'48"S 118°00'04"E, 3 Oct 1995, *P. Cuneo 192 & C. Offord* (NSW); Moorialup Creek, c. 7 km E of Porongurup Range, 34°42'S 118°3'E, 7 Sep 2014, *D.A. Young 12* (NSW); Metal Dump Reserve, Cheyne Beach Rd, 2 km from Hassell Highway, 34°51'S 118°18'E, 8 Oct 1997, *E.J. Croxford 7950* (PERTH); Near Mount Bland, Fitzgerald River Reserve, 6 Oct 1970, *P.G. Wilson 10150* (PERTH, NSW); Jorndee Creek, Cape Arid, 33°55'S 123°20'E, 1 Nov 1991, *G.J. Keighery 11941* (PERTH); Between Mount Le Grand and Lucky Bay, ca. 28 km SE of Esperance, 30 Sep 1970, *P.G. Wilson 10013* (PERTH); [Cape] Le Grand National Park, shore of the round lake NE of Frenchman Peak, 15 Oct 1991, *W. Greuter s.n.* (PERTH); Cape Le Grand National Park, 18 Feb 1967, *R.D. Royce 8390* (PERTH); Marbellup, 33°54'S 122°06'E, 1904, *H.E. Sheath s.n.* (NSW 393105).

#### *Boronia denticulata* subsp. *whoogarupensis* Duretto, subsp. nov.

Type: WESTERN AUSTRALIA: Whoogarup Range, Fitzgerald River National Park, 33°56'S 119°51'E, 22 Sep 2011, *D. Rathbone DAR 620* (holotype: PERTH 08267960) (Fig. 4).

**Etymology:** The subspecific epithet is derived from the main location where this subspecies has been collected, Whoogarup Range in eastern Fitzgerald River National Park.

Leaves linear-elliptic to linear-oblongate, 16–41 mm long, 1–2.5 mm wide; margins entire or with only very slightly raised glands. Inflorescence: peduncle and secondary inflorescence branches 9–23 mm long; pedicels 7–18 mm long, 0.3–0.5 mm wide. Sepals narrowly deltate, 2.5–3.1 mm long, 0.75–1.1 wide. Petals (5–)6–9 mm long, 4–6 mm wide. **Fig. 4.**



**Fig. 4.** *Boronia denticulata* subsp. *whoogarupensis*. a – flowering stem; b – leaf abaxial view; c – leaf abaxial view, detail; d – sepal abaxial view; e – flower. a-e – Rathbone DAR620 (PERTH 08267960, holotype). Scale bar = 30 mm for a, 15 mm for b, 7.5 mm for c, 5 mm for d, and 5 mm for e.

**Distribution:** Found in east of Fitzgerald River, eastern Fitzgerald River National Park on Whoogarup Range, Middle Mount Barren, Thumb Peak and to the north of the park at Phillips River, south-western Australia.

**Habitat:** Little ecological information has been recorded with herbarium collections but the subspecies has been collected from creek beds and sometimes on black sand. Community types not given with collections; one collection indicates the taxon was found with *Eucalyptus conferruminata* and *Thomasia* sp. Hopetoun (K.R.Newbey 4986).

**Flowering and fruiting:** Flowering material has been collected from August to December and fruiting material from October to December.

**Conservation status:** Known from few collections and four locations and mostly within Fitzgerald River National Park. Most collections provide no information on population size. Further surveys are required before an accurate conservation assessment can be made for the taxon.

**Specimens examined:** WESTERN AUSTRALIA: Whoogarup Range, 2 Dec 1960, A.S. George 1902 (PERTH); Whoogarup Range, 1 Nov 1965, A.S. George 7192 (PERTH); Thumb Peak, E of Ongerup, 27 Oct 1967, K. Newbey 2723 (PERTH); Thumb Peak, E of Ongerup, 27 Oct 1967, K. Newbey 2722 (PERTH); Middle Mount



Barren, 20 Sep 1948, C.A. Gardner 9162 (PERTH); Phillips River, 17 miles from Ravensthorpe, 27 Aug 1965, E. Wittwer 393 (PERTH).

### Acknowledgments

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